

# Precipitation and Latent Heating in Tropical Easterly Waves

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## Goals and Objectives

**Use satellite data to understand precipitation and heating during the lifecycle of tropical easterly waves (TEWs) to improve model biases in the representation of these waves.**

**Objective 1:** Determine and analyze the amount and structure of convection and precipitation over the lifecycle of TEWs across the tropics.

**Objective 2:** Examine the latent heating profiles within TEWs and their relationship with TEW intensity and evolution.

**Objective 3:** Diagnose variability in TEW precipitation processes spatially (region-to-region) and temporally (year-to-year).

**Objective 4:** Identify and understand discrepancies in latent heating profiles of TEWs in MERRA-2 reanalysis and the NASA-GISS climate model.

## Hypotheses

**General:** *The interaction between moist convection and TEWs is a major source of weather and climate model bias through biases in latent heating.*

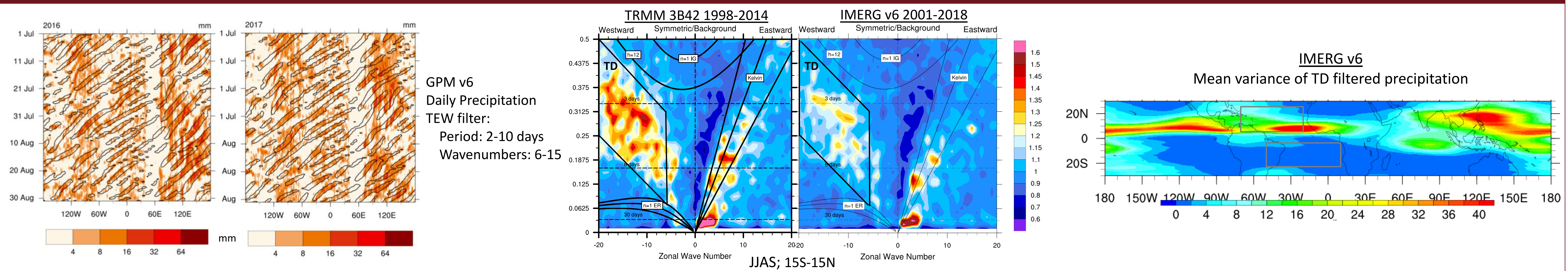
**Precipitation:** *The precipitation maximum (and convective/stratiform structure) is a function of the lifecycle of the wave as opposed to its spatial location. The maximum moves ahead of the trough as the wave matures.*

**Latent Heating:** *The vertical structure will become more “top-heavy” as the low-level curvature vorticity and precipitation increase for maturing TEWs with an associated increase in stratiform rain fraction.*

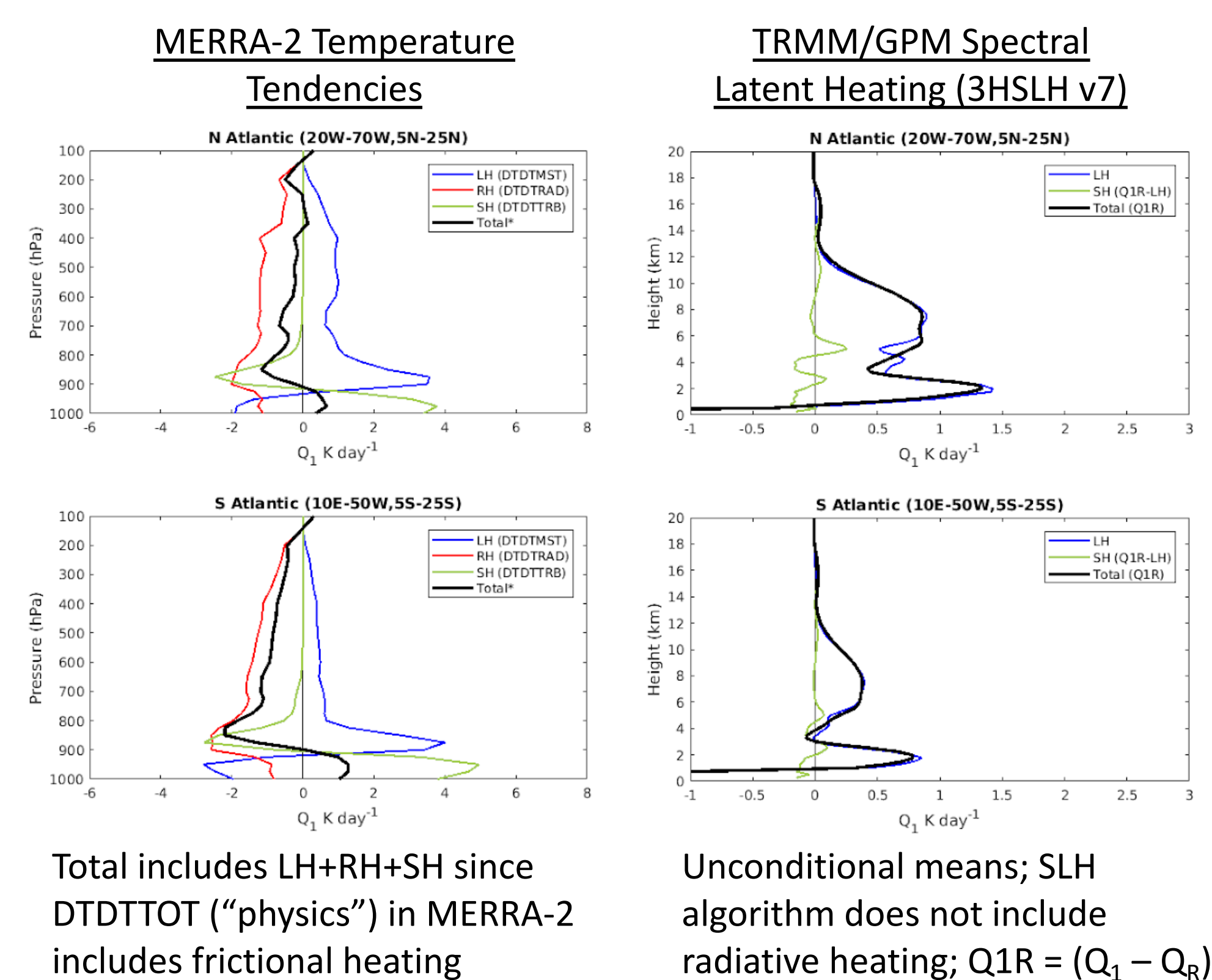
**Spatial Variability:** *The regional differences in the relationship between precipitation and wave circulation are due to inconsistencies in wave sampling methods, rather than physical differences in wave activity across basins.*

**Energy Budget:** *To simulate TEWs accurately the correct phasing and structure of precipitation in TEWs is vital to produce the correct energy budget contributions from latent heating.*

## Tropical Easterly Waves in NASA Precipitation Data



## Heating Profiles



## Summary

- TEWs important for convection and precipitation
- They occur globally but are studied little outside the Atlantic
- This study aims to understand spatial, temporal, and lifecycle variability of precipitation and heating associated with TEWs
- TEWs exist in GPM IMERG precipitation
  - IMERG spectra shows signal in TD region but less than TRMM
  - Weaker signal than expected
  - Maxima in Atlantic, E. Pac., and broad peak in W. Pac.
  - Have not removed tropical cyclones
- Latent heating magnitude is significantly less in TRMM/GPM observations than reanalysis

### References:

Hodges, K. I., 1995: Feature tracking on the unit sphere. *Mon. Wea. Rev.*, 123, 3458-3465.  
Ullrich, P. A. and Zarzycki, C. M.: TempestExtremes: a framework for scale-insensitive pointwise feature tracking on unstructured grids, *Geosci. Model Dev.*, 10, 1069–1090, <https://doi.org/10.5194/gmd-10-1069-2017>, 2017.

## Next Steps

- Identify and track individual waves in MERRA-2 & IMERG
  - TRACK (Hodges 1995)
  - TEMPEST Extremes (Ullrich and Zarzycki, 2017)
- Track using curvature or relative vorticity and precipitation
- Remove tropical cyclones
- Co-locate precipitation and heating with wave tracks
- Regional variability
- Association of waves with wet or dry years
- TEW heating in GPM/TRMM and MERRA-2
- Objectively diagnose the lifecycle of TEWs using strength and tendency to identify wave phase
- TEW heating as a function of total lifetime (i.e., short- vs. long-lived waves), areal coverage and size (i.e., small vs. large), and intensity (weak vs. strong waves).
- Energy budget analysis in MERRA-2 and NASA GISS ModelE in relation to TEW heating